

Epidemiology in Public Health Planning for Natural Disasters

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EPIDEMIOLOGY has proved useful in the study and prevention of accidents of various types as well as epidemics of communicable diseases. Disasters may be defined arbitrarily as epidemics of accidents in which 25 or more people are seriously injured or killed. Therefore it seems reasonable to believe that when the epidemiology of various kinds of natural disasters is known many of them can also be predicted and prevented or at least controlled (1). Moreover an epidemiologic analysis of the disaster provides a sound basis for public health program planning.

The word epidemiology, derived from the Greek *epi* (on or upon) and *demos* (the people) implies something inflicted upon the people. Natural disasters, such as earthquakes, as well as diseases, fit this definition.

At 10:51 p.m. on September 1, 1962, an earthquake devastated part of the Central Plateau of Iran, a country which suffered more than 115 major earthquakes from 1904 to 1961. A detailed report of this catastrophe by Saidi (2) is used in this paper as a basis for examination of the epidemiologic approach to public health planning for a natural disaster. It should be made clear that we did not have firsthand observation of the Iranian earthquake. This earthquake was merely used as a conceptual model to illustrate the epidemiology of a natural disaster.

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Epidemiologists conveniently classify three major types of factors which influence the incidence of a disease—agent factors, host factors, and environmental factors. In natural disasters, the agent would be the factor producing the actual injury or disease; the hosts would be human beings and to a lesser extent animals; and environmental factors, the physical, chemical, biological, and social climates in which a disaster occurs.

The epidemiologist initially takes three steps in investigating an epidemic: (a) He confirms the diagnosis. Was there an earthquake and if so, was it a major or a minor one? (b) He determines if there is an epidemic. Was there a disaster killing or seriously injuring 25 or more people? (c) The epidemiologist next characterizes the epidemic as to time, place, and the victims. When did the earthquake take place, how large an area was affected, how much damage was done, approximately how many people were injured, dead, or missing, and what are the immediate needs of the survivors?

This type of community diagnosis is essential for intelligent public health program planning and is needed as soon as possible. Like diseases, disasters have definite patterns, so that a knowledge about their usual characteristics may prove valuable. For example, in earthquakes fractures and crushing wounds are the usual types of injuries if secondary fires have not caused burns and tidal waves have not caused people to drown.

Information on the occurrence, duration, direction, and intensity of an earthquake can be obtained through seismograph reports as well as by telephone, radio, and wireless. In the

Iranian earthquake, tremors were felt in Tehran, the capital, some 120 miles away, so that there was no question about the earthquake's occurrence. An aerial evaluation of the disaster area had to be delayed until daylight. A survey by airplane confirmed that a major disaster had happened and provided valuable information about the geographic area affected, the percentage of buildings destroyed, and the number of survivors seen. (In the United States aerial surveys are used after a disaster to assist the Governor of a State in obtaining Federal funds, under the provisions of Public Law 875, for use in recovery and rehabilitation of an area. The latter could include funds for vector control and other measures.)

Additional helicopter reconnaissance flights supplied information about the immediate needs of the people, both the injured and the healthy. Previously collected geographic and population data indicated approximately how many villages and people were in the disaster area. It was not necessary to visit every village to get a crude estimate of the magnitude of the disaster. Simple calculations provided a rough idea about how many dead would have to be buried, how many people would require medical care, and how many persons would need food, clothing, and shelter. This community diagnosis proved useful in planning rescue operations.

Based on epidemiologic analysis of agent, host, and environmental factors, what are some of the more important public health needs of the people in such a catastrophe?

Agent Factors

The primary agent causing deaths and injuries in the Iranian earthquake was collapsing buildings. Constructed of dried mud, tree trunks, and twigs, the structures offered little resistance to the tremors. Fire was only a minor primary agent since the houses lacked electricity, central heating, or much wood construction. Since the earthquake occurred far inland, tidal waves did not cause anyone to drown.

Nothing could have been done to prevent the buildings as constructed from collapsing. However, trained rescue workers and demolition experts could prevent additional injuries from unsafe buildings, and unsafe buildings could be

condemned. At present there is no way to control the associated causative agent, the earthquake itself.

Secondary agents threatening health and life in the days and weeks following the earthquake included communicable diseases, malnutrition, and exposure to cold owing to lack of shelter. Environmental sanitation, pest control, early reporting of diseases, immunizations (especially typhoid and paratyphoid and tetanus for the injured), isolation, and early treatment of the diseased may help to control communicable diseases. Essential foods, vitamins, and minerals will be needed to combat nutritional diseases. If the weather is inclement, temporary shelters, clothing, blankets, fuel, and stoves may have to be supplied.

As to delayed agents, such as serum sickness, transfusion reactions, wound infections, mental aberrations, chronic diseases, and other complications among the injured, it is necessary to know that they may develop, to try to prevent them, and to treat them should they arise.

Host Factors

The area of Iran afflicted by the earthquake was sparsely populated, containing only about 150 villages. However, almost the entire population of some 150,000 persons was at risk of being killed or injured. About 12,000 of these persons were killed, 1,200 were seriously injured, and 30,000 families were left homeless by the earthquake. Also there were heavy losses of livestock, as the animals were kept inside the mud houses at night. A few persons sleeping outdoors when the disaster struck were spared. Fractures and crushing injuries to the head, chest, and abdomen were the major types of injuries requiring medical care. Those who were ill, injured, or unable to help themselves, including small infants, were especially likely to become dehydrated and die if not rescued early. The great numbers killed within a short period of time created an almost insurmountable burial problem. Mass burial was instituted.

The shock, confusion, anxiety, and bereavement the people experienced immediately after the earthquake impaired self-help and rescue operations. Outside assistance to many villages was unavailable for several days, no doubt add-

ing to the villagers' anxiety and fear. Some persons were killed when they wandered into unsafe buildings searching for their loved ones or possessions. Later the afflicted population suffered additional stress from lack of food, clothing, and shelter. While the educational level of the people was low and they had scanty knowledge of first aid, most of them, being farmers, knew how to live off the land. All of these host factors played a role in ultimate survival.

When disaster strikes, whether it is an epidemic of disease or some other catastrophe such as an earthquake, the general health of the people is an important consideration in planning rescue and public health measures. What the people's nutritional and immunization status is and what diseases are endemic among them will affect their chances of survival.

Skilled rescue and first aid can prevent complications; simple fractures may not become compound if treated properly. Operations required to relieve the injured will probably include rescue, triage, first aid, identification and tagging, and evacuation to treatment centers (with a record kept of where casualties are transferred).

Some groups will have special health requirements. Infants will need milk and vitamins, heart patients digitalis, and diabetics insulin; pregnant women will require childbirth care. Almost all the disaster victims will probably need food, clothing, and shelter. Good rescue operations and communications will lend the people psychological support.

Burial of the dead may be an urgent health problem of high priority. The only practical means of burying great numbers is by mass burial. This can best be accomplished by use of bulldozers or tractors to dig large trenches. Individual religious ceremonies may have to be abandoned. However, it is highly desirable to identify the dead and keep a list of them. This will lessen fear and anxiety among the bereaved.

Environmental Factors

Physical environment. The September 1962 Iranian earthquake covered 23,000 square miles. The terrain was that of oases scattered among deserts and mountains. The closest medical center was some 90 miles away. Lack of com-

munications and paved roads to isolated villages made rescue difficult. In September, dry heat during the day and extreme cold during the night is usual. Freezing winter weather was only a few weeks away. The time of day the earthquake struck, 10:51 p.m., contributed to the number of casualties. Had it occurred in daytime working hours, fewer persons would have been killed, and they would have been predominantly women and children. Since most of the victims' homes were completely destroyed or made unsafe for habitation, provision of shelter and clothing posed difficulties.

Water, milk, and other food supplies were disrupted. A limited supply of food was available. Flour mills had been damaged so that there was a shortage of meal. No cold storage was available to preserve perishables; therefore nonperishable foods, such as canned goods, were needed. Fuel, cooking utensils, and mess kits were essential. The loss of most domestic animals caused an acute shortage of milk; dried milk was needed for infants. Fortunately grapes were about to be harvested. Water was short and much of it contaminated. Facilities were required to boil it and chlorine or iodine tablets, canteens, and Lyster bags were needed to purify it. Excreta disposal was difficult.

Most environmental health problems that arise in a disaster can be solved by procedures used in military field operations (3). Water rationing may be necessary. Slit trenches and pit or pail latrines offer means of sewage disposal. Trash can be burned and garbage buried. Tents, lean-to's, barracks, and other improvised facilities may provide emergency shelter.

Chemical environment. No change occurred in the chemical environment of the disaster area after the earthquake, except for the introduction of insecticides for pest control and of slaked lime used as a disinfectant and deodorant in excreta disposal and on decomposing bodies. These uses created no recognizable hazards.

In such situations, insecticides especially dangerous to man are, of course, to be avoided.

Biological environment. The earthquake resulted in almost as drastic a change in the biological environment of its victims as in their physical environment. Smallpox, typhus, typhoid, and tuberculosis are endemic in Iran,

and it was feared they might cause widespread epidemics. Saidi (2) reported no epidemics broke out despite "favorable circumstances." Mobile units of the Ministry of Health sprayed DDT and carried out mass vaccination against typhoid. Survivors of the earthquake were crowded into camps of tents and improvised shelters. Persons with various disease and immunization patterns were mixed together, especially when they were evacuated to larger cities. The lack of safe water for drinking and bathing provided other hazards. As noted earlier, the 12,000 persons killed within a short period created an almost insurmountable burial problem. Many human and animal bodies could not be excavated from the ruins for several days, increasing the possibility of an outbreak of disease. Food in the ruins provided an opportunity for disease-carrying rodents and insects to proliferate. For approximately every 10 persons dead there was 1 person seriously injured.

In other natural disasters, the ratio of injured persons to the general population may be higher than in the Iranian earthquake, with consequently greater demands on medical care personnel, supplies, and facilities.

Animals killed in such disasters must be slaughtered immediately for food or buried in mass graves. DDT and other insecticides may be required for insect control. Proper disposal of dead bodies, garbage, and other food sources, plus use of rodenticides, should control rodents. As in Iran, inhabitants may need firearms to protect themselves from wild animals.

Rescue workers should know what diseases are endemic in a disaster area and take measures to prevent outbreaks. In addition, every effort needs to be made to avoid crowding people too closely together in the temporary shelters. Those with communicable diseases must be isolated and treated in an infirmary, which might be established in one of the shelters. Mixing of persons from different villages during evacuation is to be avoided. Mixing of susceptibles with the diseased is a sure way to start and perpetuate epidemics of communicable disease.

Social environment. Most of the Iranian earthquake victims lived in small and medium-sized villages and had low per capita incomes. Their important cultural values were family activity, the home, farmland, and livestock.

Needless to say, the earthquake disrupted community, family, and personal life. It shattered the institutional framework of society. Established ways of doing things were suddenly changed. Community and familial roles were shifted. The people's leaders and heads of their families were gone; others had to take their places. Many children became orphans. The fact that livestock was housed with the families added to the sense of loss.

The cultural view that the disaster was an act of fate probably retarded self-help and reconstruction. Some seriously injured patients refused hospitalization. Medical institutions were overrun by the sudden influx of large numbers of patients. The religious rite of ablution had to be discontinued because of the overwhelming number dead and the shortage of water. Some peasants had to migrate to large cities where they did not have the necessary skills to earn a livelihood.

After a disaster, the social environment is the most difficult thing to restore. Actually it cannot be restored. However, a social system similar to the one destroyed might be created. Obviously, the local society will not have the economic resources to meet its complex problems. About all that may be left, as in Iran, may be the survivors and their land. Assistance from the national government will no doubt be essential to rescue and rehabilitate the afflicted society.

One of the more important early decisions may be the determination of whether the healthy survivors should remain in the same general geographic area or be temporarily or permanently relocated. Economic, health, and humanitarian considerations will affect the decision. To put it another way, what is the most economical, safe, and efficient way to rebuild this society so that it can become self-sufficient in the shortest period of time?

If the physical community is destroyed and the social community has been drastically altered, possible solutions include rebuilding of the physical and social community, either at the same or at another site; relocating the social community in another physical community; or relocating individuals in other physical communities, abandoning the old physical and social communities.

A dead family member cannot be replaced, but there may be remarriage among the survivors. Orphans require adult care and supervision in foster homes or orphanages. Family members separated because of injuries or other causes should be reunited with the family group as soon as practical. New roles will need to be established. For example, a son may become the family breadwinner in place of his dead father.

Measures to be considered to help the individual include restoration of health, the provision of work so that he can develop confidence and self-respect, and encouragement of group activities which will make the person feel he is a part of the community.

Occupational opportunities may have to be created. Possibly disaster victims can continue in their former occupations, at the old location or at a new one. Otherwise provision might be made for learning a new trade, either in the old or a new location. Unemployment and welfare assistance may be required.

The family dwelling place is an important cultural value in the disaster victims' society. Tents and temporary buildings will probably be needed to provide shelter until more permanent housing is available. Houses may either be rebuilt at the former site or suitable housing made available elsewhere. In building new housing in an earthquake area, probably some consideration should be given to making it more resistant to earthquake damage, but it should conform to people's expectation of housing. For example, in the Iranian earthquake area it might prove unwise to construct houses without space for domestic animals.

In the period following the disaster most of

the survivors may at first be dependent on the government for their basic living needs. Welfare assistance and long-term loans are possible measures to return a society to economic stability. If the society is similar to that of the Iranians and is to remain in a rural village, livestock may be supplied to families so that they can establish herds.

The effects of migration of such a society from a rural setting to a large city should be carefully considered. Very likely a change to city living would be accompanied by a migration downward in the social class structure. The varieties of social pathology that can result from these two kinds of migration have been well documented by sociologists.

Iran mobilized all its resources to bring relief to the disaster victims. Other countries sent supplies and personnel. Yet the social and economic effects of this widespread disaster will undoubtedly be felt in that country for many years.

Following any such natural disaster, we suggest that the health department establish a community diagnosis, using epidemiologic methods, as soon as possible. An analysis of the agent, host, and environmental factors of the catastrophe will provide a sound basis for public health program planning.

REFERENCES

- (1) Saylor, L. F., and Gordon, J. E.: The medical component of natural disasters. *Amer J Med Sci* 234: 342-362 (1957).
- (2) Saidi, F.: The 1962 earthquake in Iran. *New Eng J Med* 268: 929-932, Apr. 25, 1963.
- (3) Coates, J. B., Jr., and Hoff, E. C.: Preventive medicine in World War II. Vol. 2, Environmental hygiene. U.S. Government Printing Office, Washington, D.C., 1955.